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Software Architecture
Concepts and Views
UML Introduction

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DR&CG Meeting

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Outline And Biases

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- **Biases - Importance of**
  - **Interface-based design**
  - **Good programmers vs. Languages**
  - **Iterative development of requirements and design**
- **Outline – TENA free discussion of**
  - **Software architecture concepts**
  - **Visio Demo**
  - **UML tutorial**
- **Be happy to discuss our TENA experiences and plans at the end of the day**
  - **TENA – RMI alternative functionality - JXTA**

How Did Software Architecture Get To Be An Important Idea Anyway

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- Interesting characteristics of modern systems
  - Homogenous hardware/software configurations, constantly evolving
  - Remote autonomous processing
  - Distributed, replicated, non-uniform state – time
  - Asynchronous, insecure, variable speed communications
  - Frequent partial failures
- Difficult issues to grapple with and not particularly connected to any specific application
- System development will be much easier if there is only one solution to these issues employed

Software Architecture Definition

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- **Without doubt the most ill-defined, important concept I know about.**
- **The most useful definition I can give you is:**
- **Rules by which the non-functional requirements are achieved.**
  - **Requirements other than computing correct results.**
  - **Constraints.**
    - » **Apply to the systems a whole.**
      - – **e.g., Inter-operability.**
  - **Qualities.**
    - » **Usability, extensibility.**
    - » **QOS, performance, reliability.**

Non-Functional Requirements Examples

- **Scale**
  - The amount of simultaneous computing and distribution a system must support
- **Security**
  - Protection from unauthorized users
  - Protection from unauthorized uses
- **Fault-tolerance**
  - Up-time
  - Response to failures of components

The Battlegrounds For Software Architecture Consultants Are:

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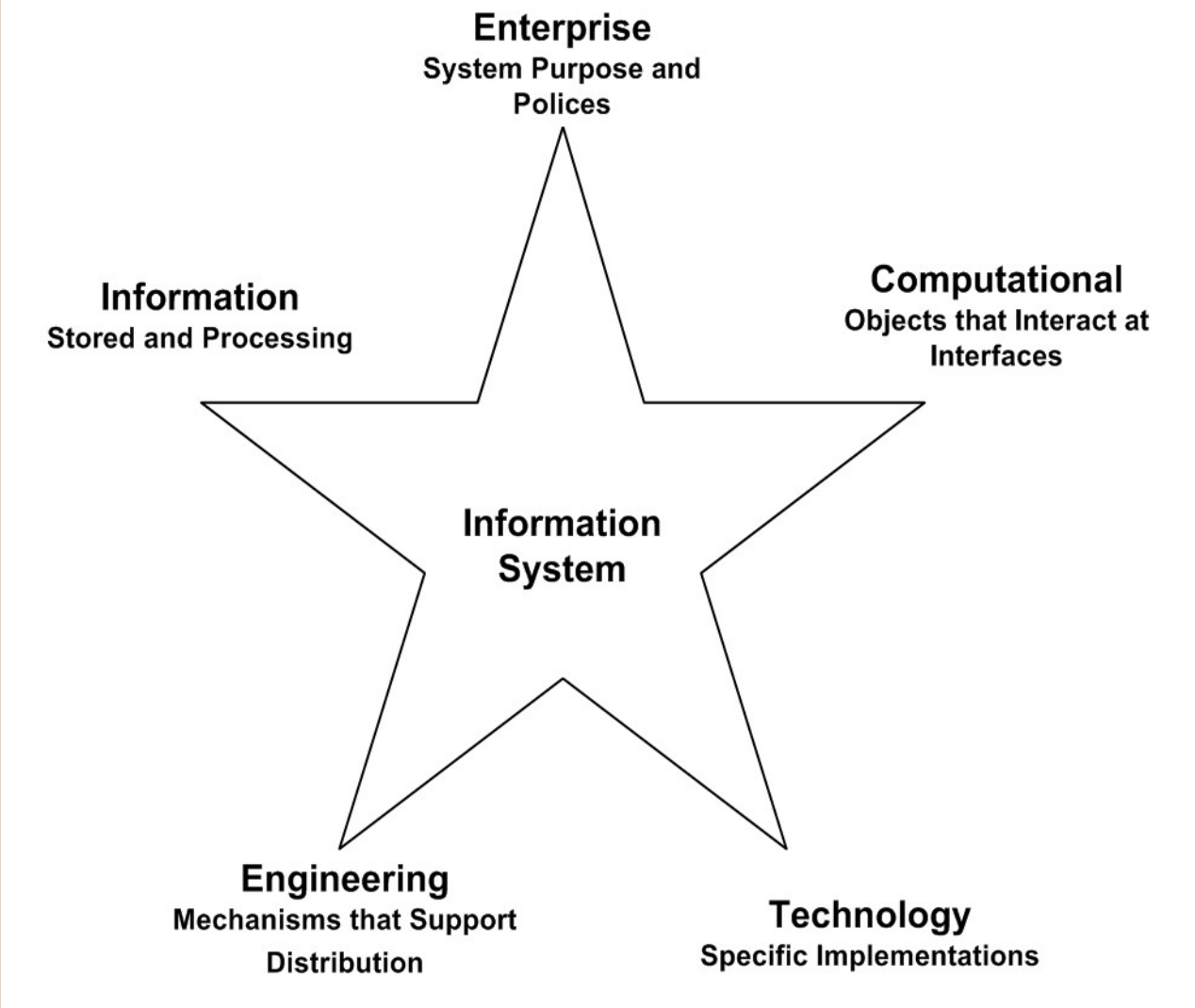
- Terminology
  - Solvable
- A-Priori views
  - Solvable by rational people
  - Discuss
    - » RM-ODP: Reference Model for Open Distributed Processing
    - » An HP approach
    - » Favorite business consultant view
- Completeness: CMM vs. Extreme Programming
  - Religious debate
  - Don’t go there
  - Value, truth, and beauty in both camps

RM-ODP: Reference Model For Open Distributed Systems



Open Distributed Processing Object Model

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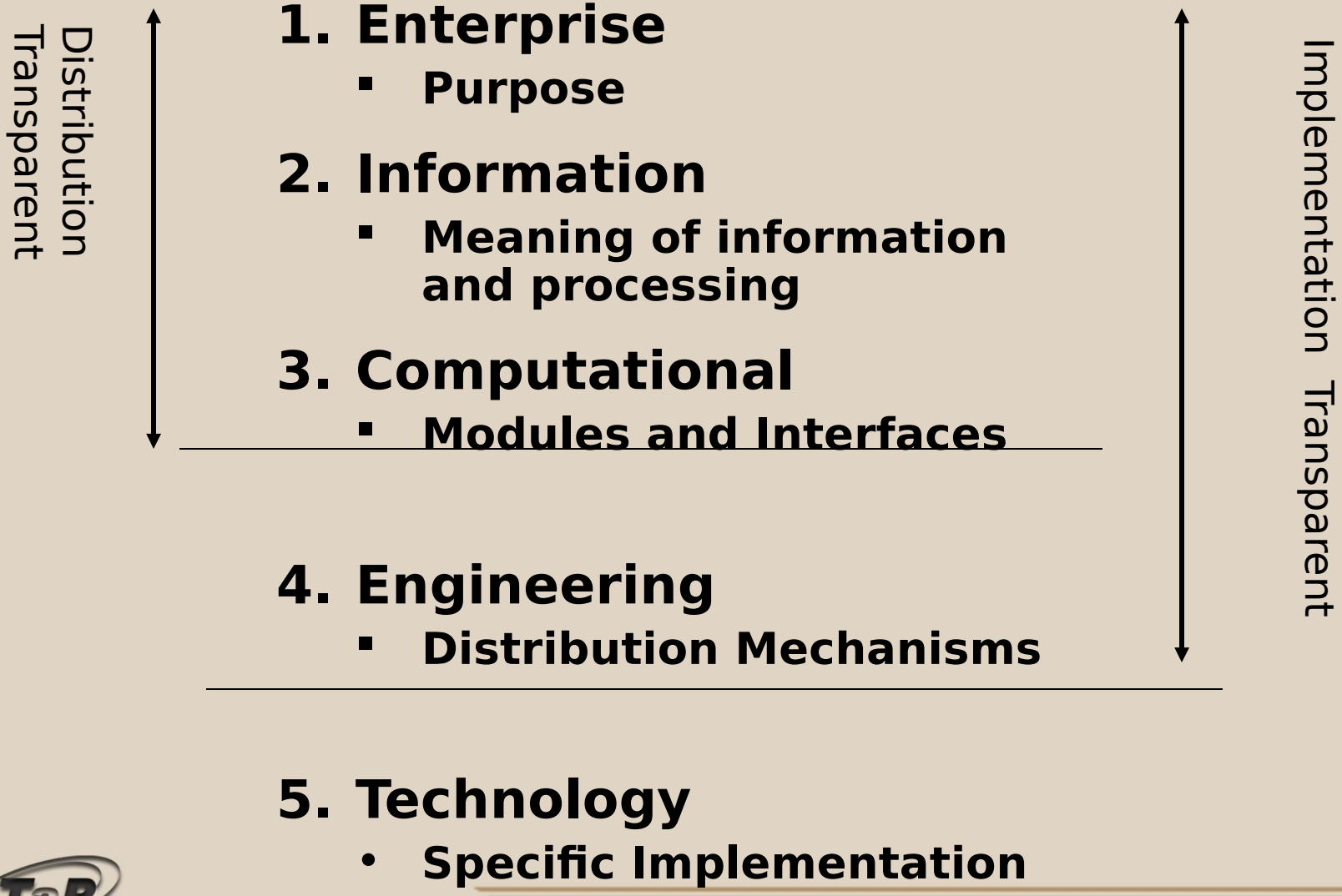
- **Objects are entities containing information and offering services**
  - **Arbitrary granularity, behavior, and parallelism**
- **System is interacting objects**
  - **Interactions between objects are not constrained**
- **Encapsulation**
  - **Information hidden and accessible only through interfaces**
  - **No side effects**
- **Abstraction**
  - **Processing implementation hidden behind interfaces**

RM-ODP Viewpoints
Design Independence



RM-ODP Viewpoints
Software Engineering

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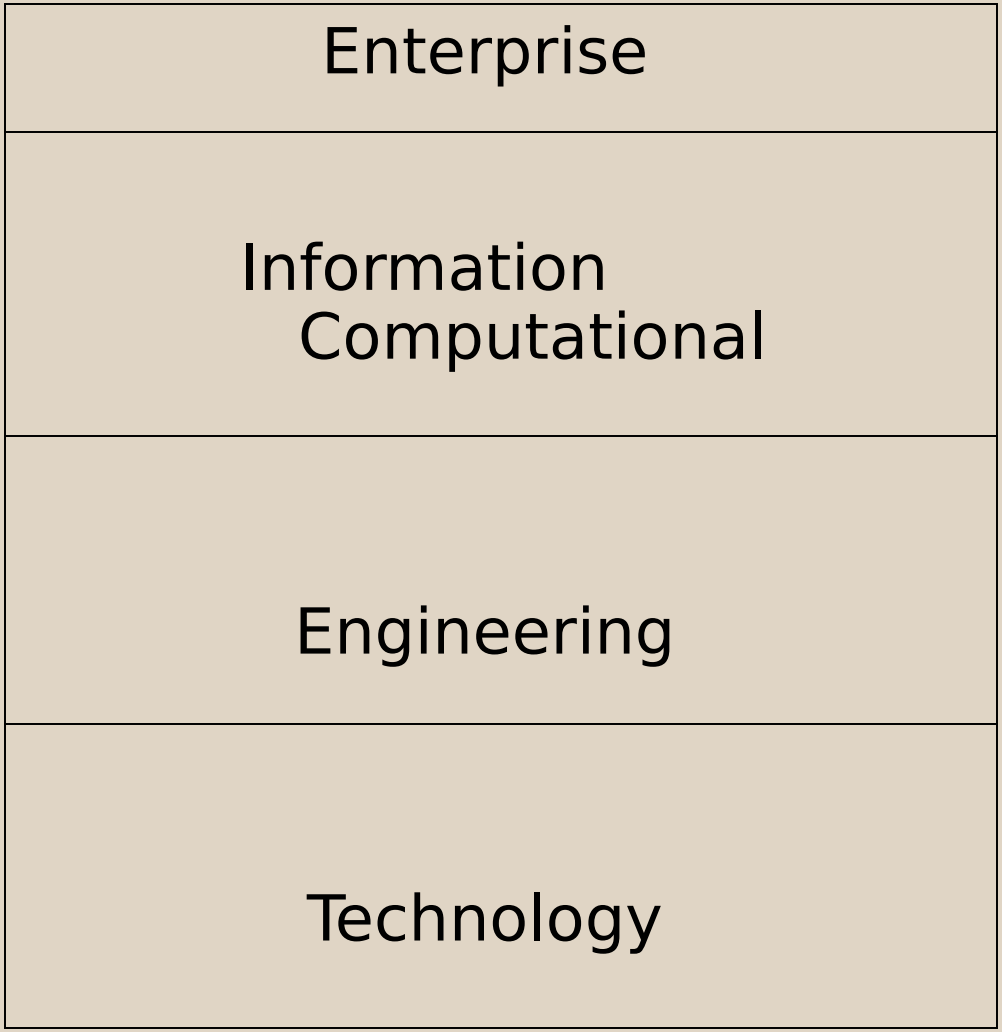
Requirements Analysis

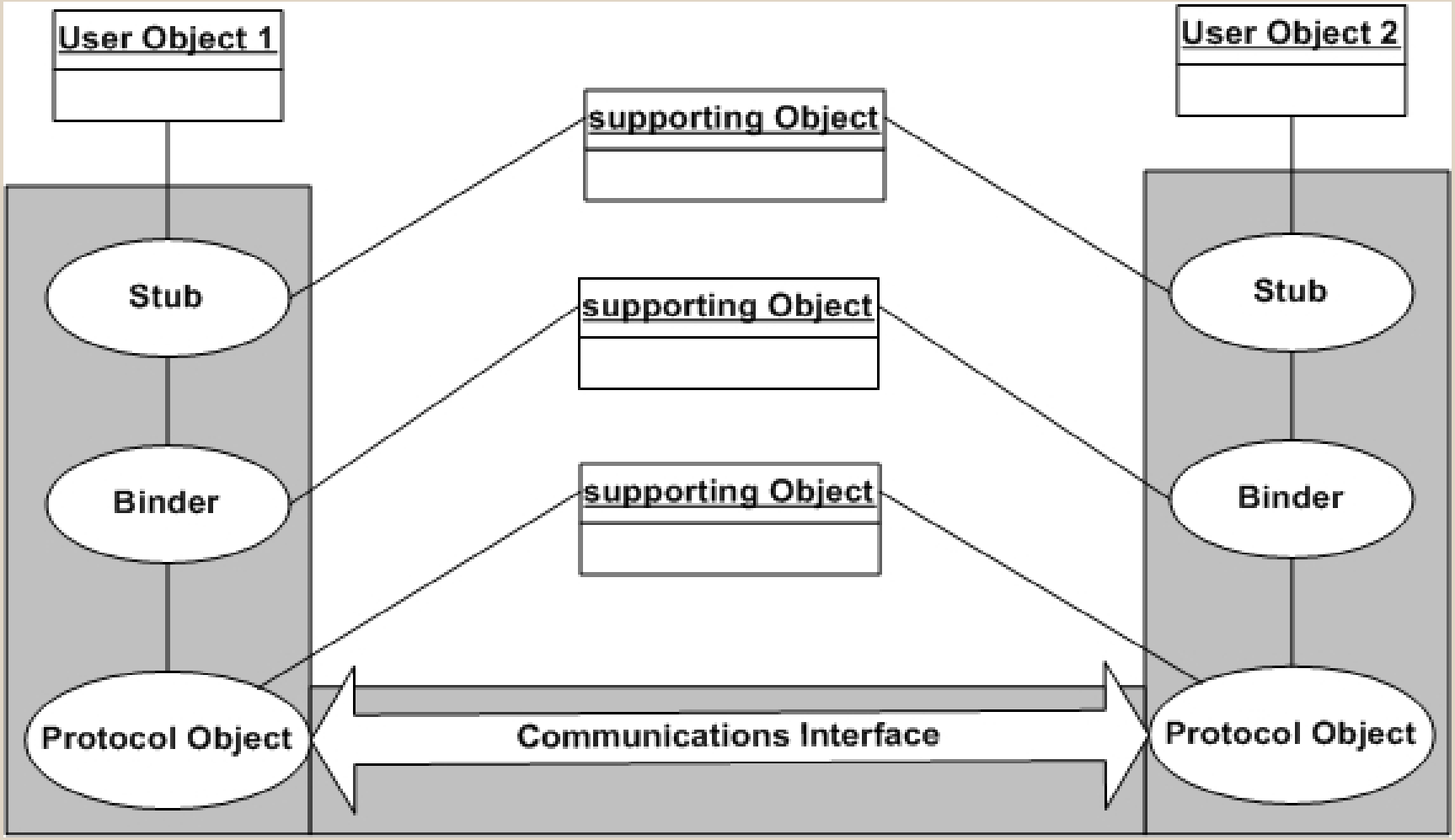
Functional Specification

Design

Implementation



Channel Abstraction



Transparencies

- **Functionality which hides some common complexity**
- **Intended to shift effort from application developer to infrastructure developer**
- **Recipes far common-case solutions**
  - **Optional don't force for all applications**

Transparency Types

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Transparency	Guarantee
Access	Masks platform-protocol difference in representation and invocation mechanisms
Failure	Masks failures and recover of Objects
Location	Masks information needed to find and bind
Migration	Masks awareness of changes in location of the object from itself
Relocation	Masks changes in location of interfaces from client objects
Replication	Maintains consisting of a group of replica objects with a common interfold
Persistence	Masks activation and deactivation
Transactions	Masks coordination to achieve consistency

CORBA provides support for location, access, and partial support for persistence. Multi-language support a key issue.

Access Transparency

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Access transparency is achieved by configuring the channel with stubs which:

- **Are accessed with local procedure call semantics**
- **Convert the interaction into a sequence of message passing**
- **Marshals and unmarshals data to convert between different representations**

Relocation Transparency

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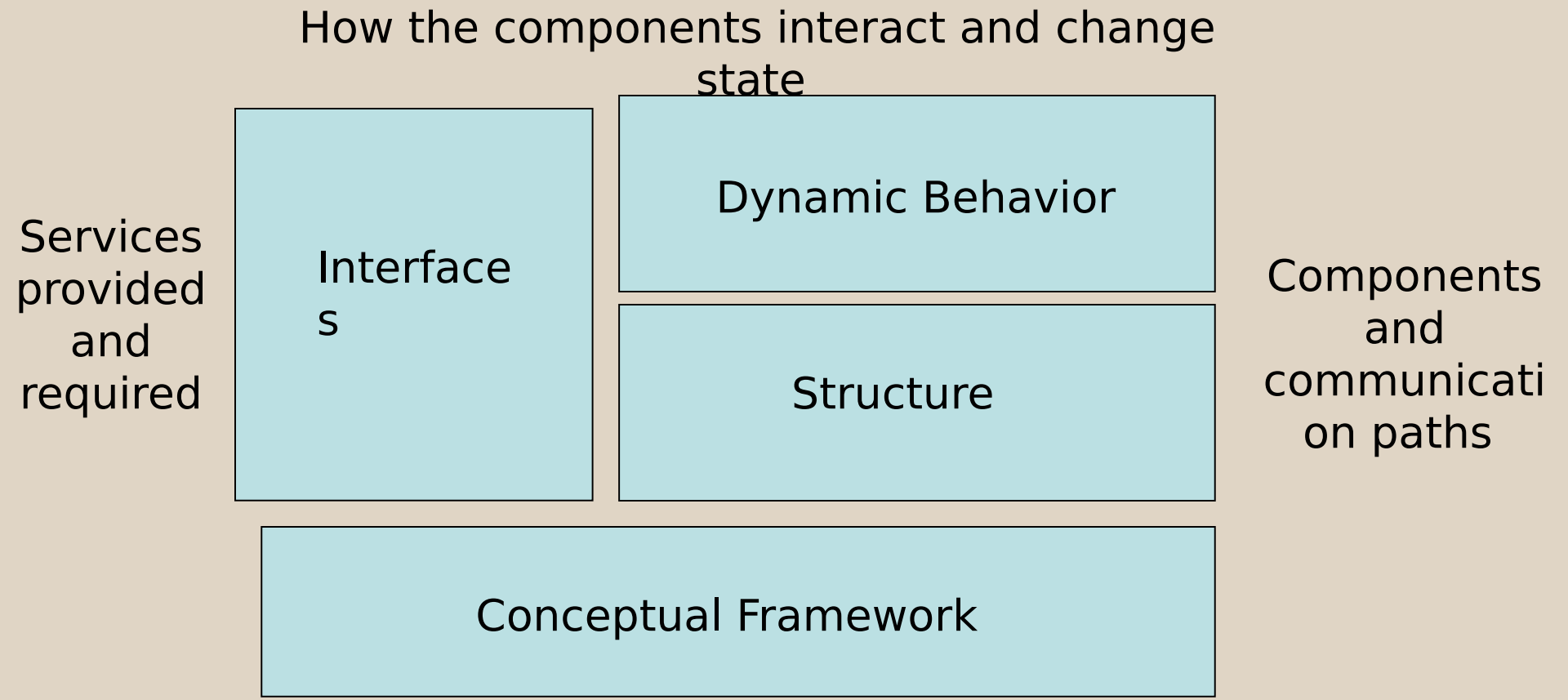
Achieved by configuring the channel with binder objects which:

- **Reports the location of it's processing thread to a locator service when the object is created, deleted, or moved**
- **Obtains the location of any interacting object**
- **Consequently**
  - » **Interacting user objects need not know each other's location**
  - » **Either user object can be moved**

Transactional Transparency

- **Transactional transparency is very difficult to provide**
- **Requires**
  - **Reporting of the execution/undo of actions of interest to a transaction service**
    - » **Reading/writing transaction protected data**
  - **Interaction with the transaction service to arrange commit/abort behavior**
  - **Implement/start undo actions and restart transactions on request of the transaction service**

ODP Too Abstract For Real Designs: An HP Approach



A Business Consultant View

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Meta-Architecture

- Vision
- Style and philosophy
- Key Concepts and Mechanisms

Architecture

- Structure and Relationship.
- Interface definition
- Static and dynamic views

Architecture Guidelines and Policies

- Standards
- Frameworks

Styles

- Batch Sequential
- Pipes and Filters
- Main Program and Subroutines
- Object-Oriented
- Layered – Call and Return
- Communicating process and event systems
- Repository and Blackboard
- Rule-Based
- Communication Middleware

Architecture

- **Conceptual**
  - **Components and connections**
    - » **CRC cards level**
      - – **Component responsibility collaborators rational**
- **Logical**
  - **Structure - interface definitions- protocols**
- **Execution**
  - **Maps to processes aid tasks**
  - **Synchronization requirements**

Generic Software Paradigms: Background For UML Discussions

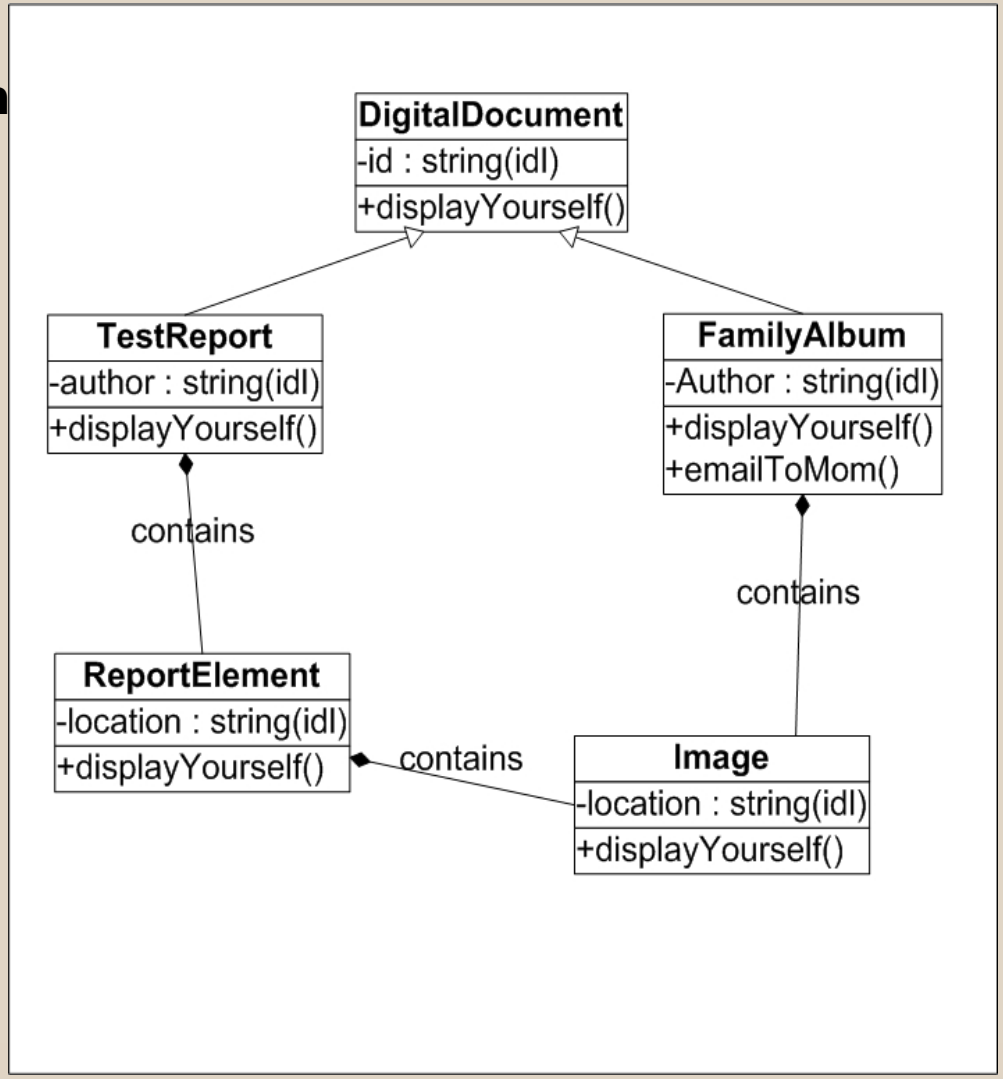
- Procedural
- Object-Oriented
- Components

Procedural

- **Common definition is that**
  - **Computer program stores algorithms separate from data**
  - **Algorithms retrieve, transform, and store data**
- **Weakness is that a data change may ripple through an entire program**

Object-Oriented

- **Key idea - Encapsulation**
  - **Store data and algorithm to manipulate data together**
  - **Hide implementation details behind Interface**
- **Key language concepts:**
  - **Identity**
  - **Classification**
  - **Polymorphism**
  - **Inheritance**



O-O Heresies from Dr. Thompkins

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- **Encapsulation and Polymorphism are properties of interface design, not programming languages**
- **Inheritance is certainly one way to generate reuse, but interface design is probably the first order effect**
- **Essentially all complex software constructs are only modifiable by their original developers, regardless of the language they are written in.**
  - **Interface design is the key way to evolve systems that utilize multiple constructs**

Components

- **Key principles**
  - **Encapsulation – Polymorphism**
  - **Late Binding**
- **Focus reuse efforts on composition at the interface design level not inheritance**
- **Late-Binding gives interoperability across languages and systems**
- **Component Infrastructures**
  - **Sun and J2E2**
  - **Microsoft and .Net**
  - **CORBA**
  - **HLA and TENA ???**

Comments On The Object-Model Approval Task

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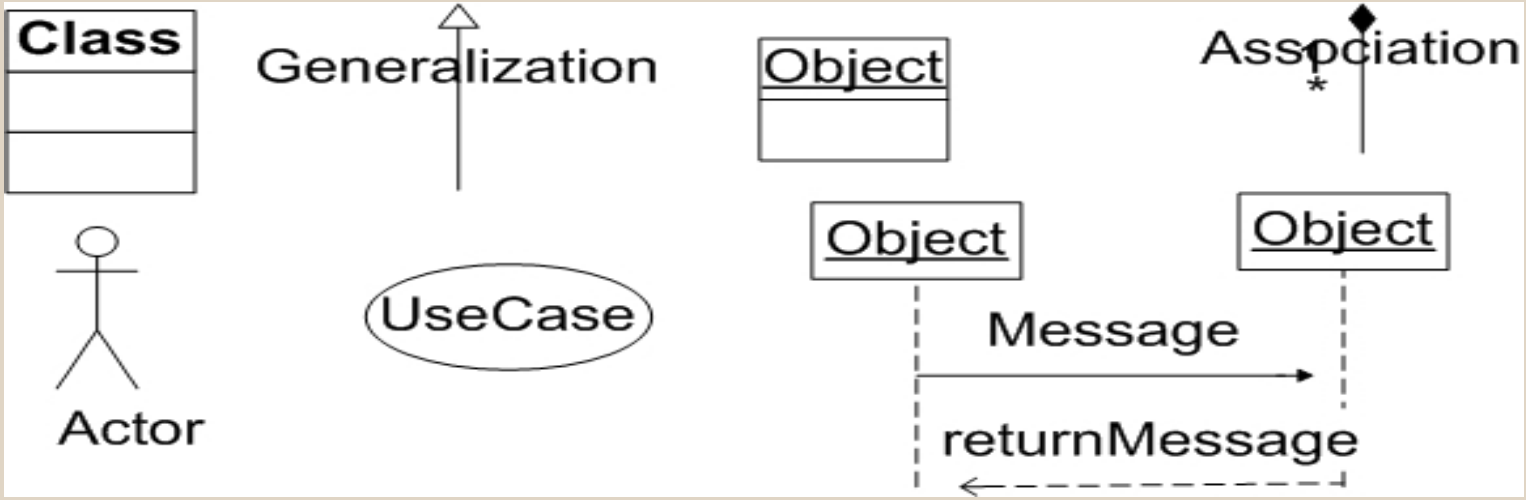
- Group has been tasked to review some detailed mdels developed over time by the technical specialists
  - DR&CG needs to be clear on what value it plan to add to that process before we “design” the process.
- I believe there needs to be additional focus at levels of abstraction above the Object Models
- Some examples:
  - What are the common usage scenarios
  - What qualities must an infrastructure provide to support those scenarios
  - Build some example applications that can be distributed to potential users

Break And Questions

Software Architecture Descriptions
UML: Unified Modeling Language

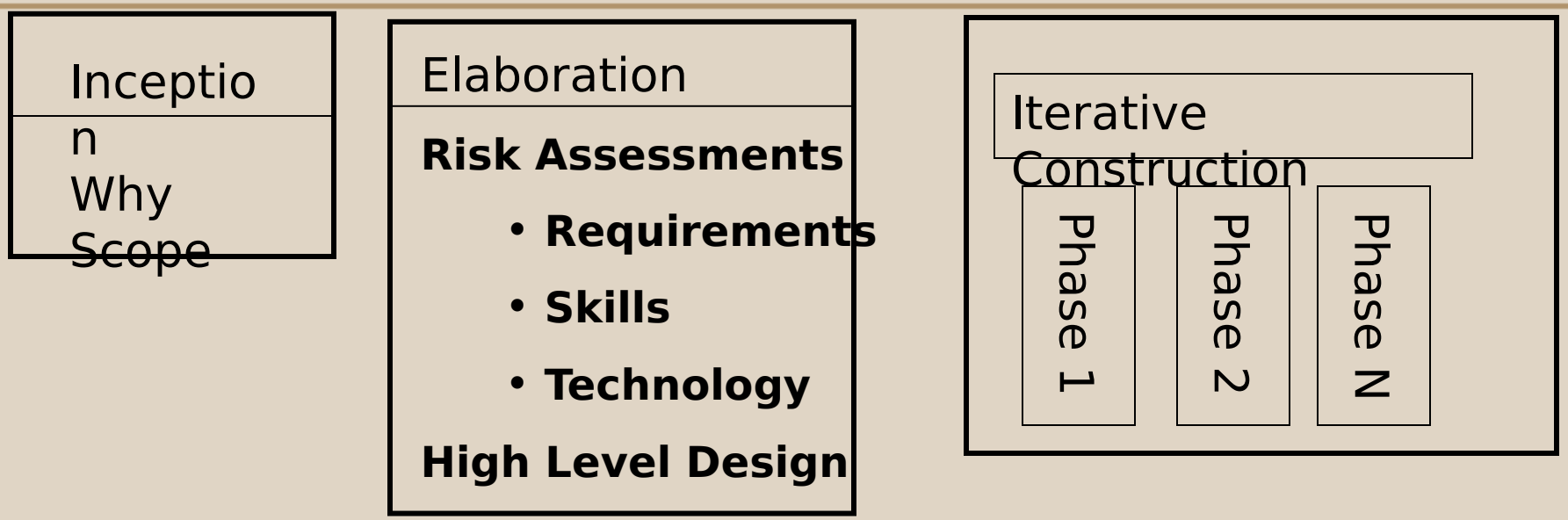


More that 100 symbols at my last count

The issue is what/when to use:

- **Development process view**
- **Architecture view**

Development Process View



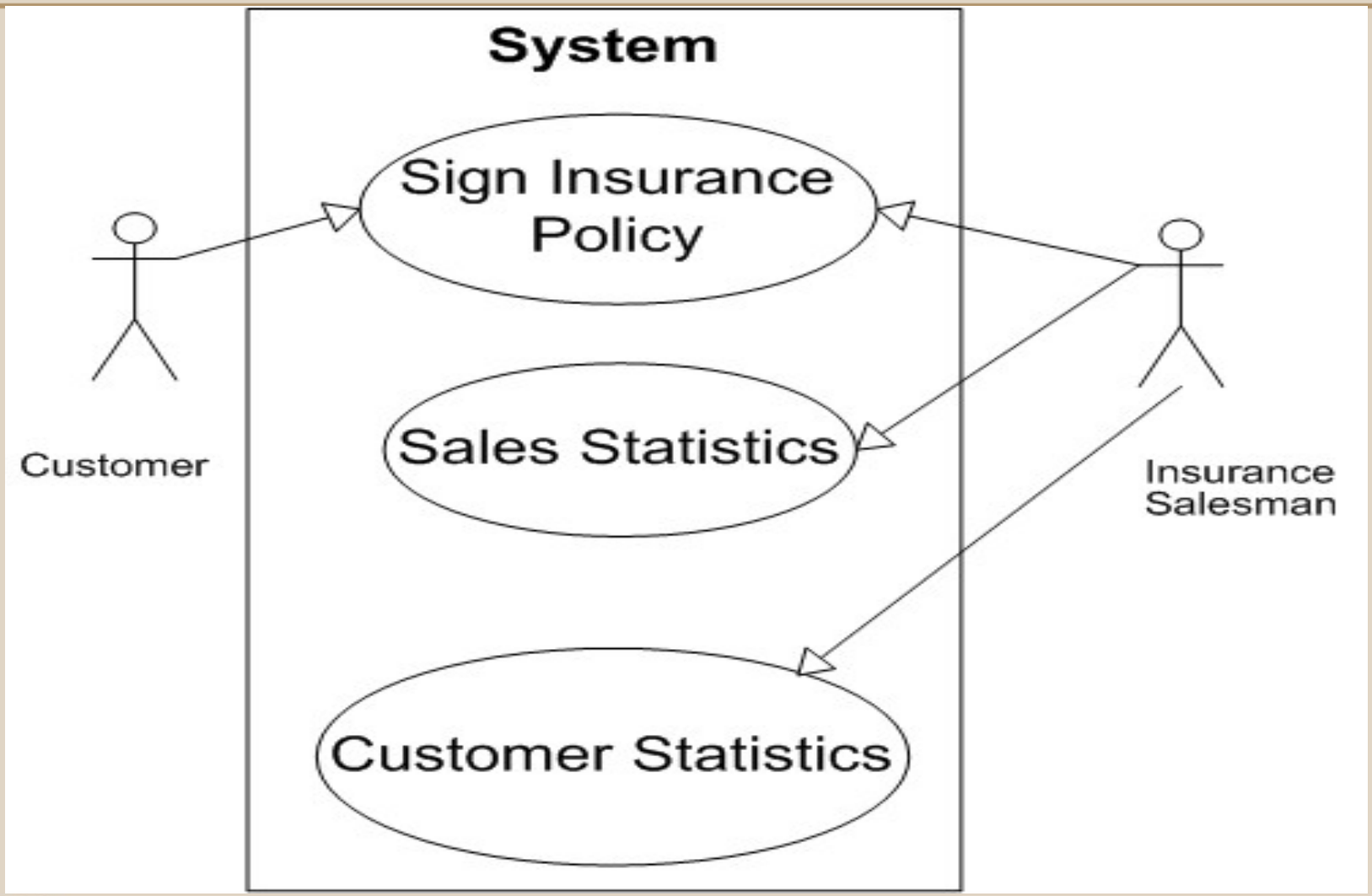
UML Tools

- Use Cases
- Context Diagrams
- Class Diagrams
- Activity

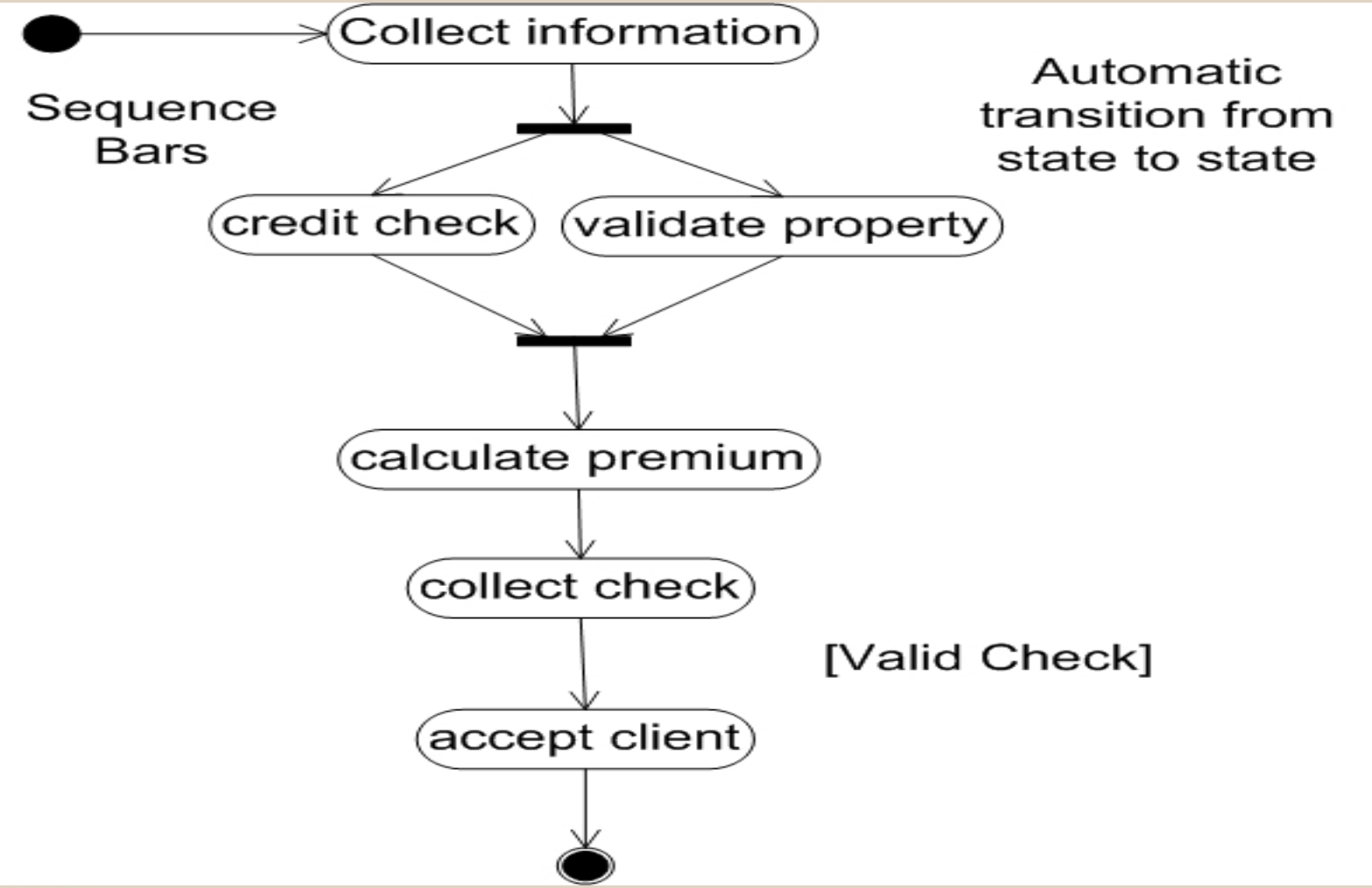
UML Tools

- Component Diagrams
- State Charts
- Sequence Diagrams

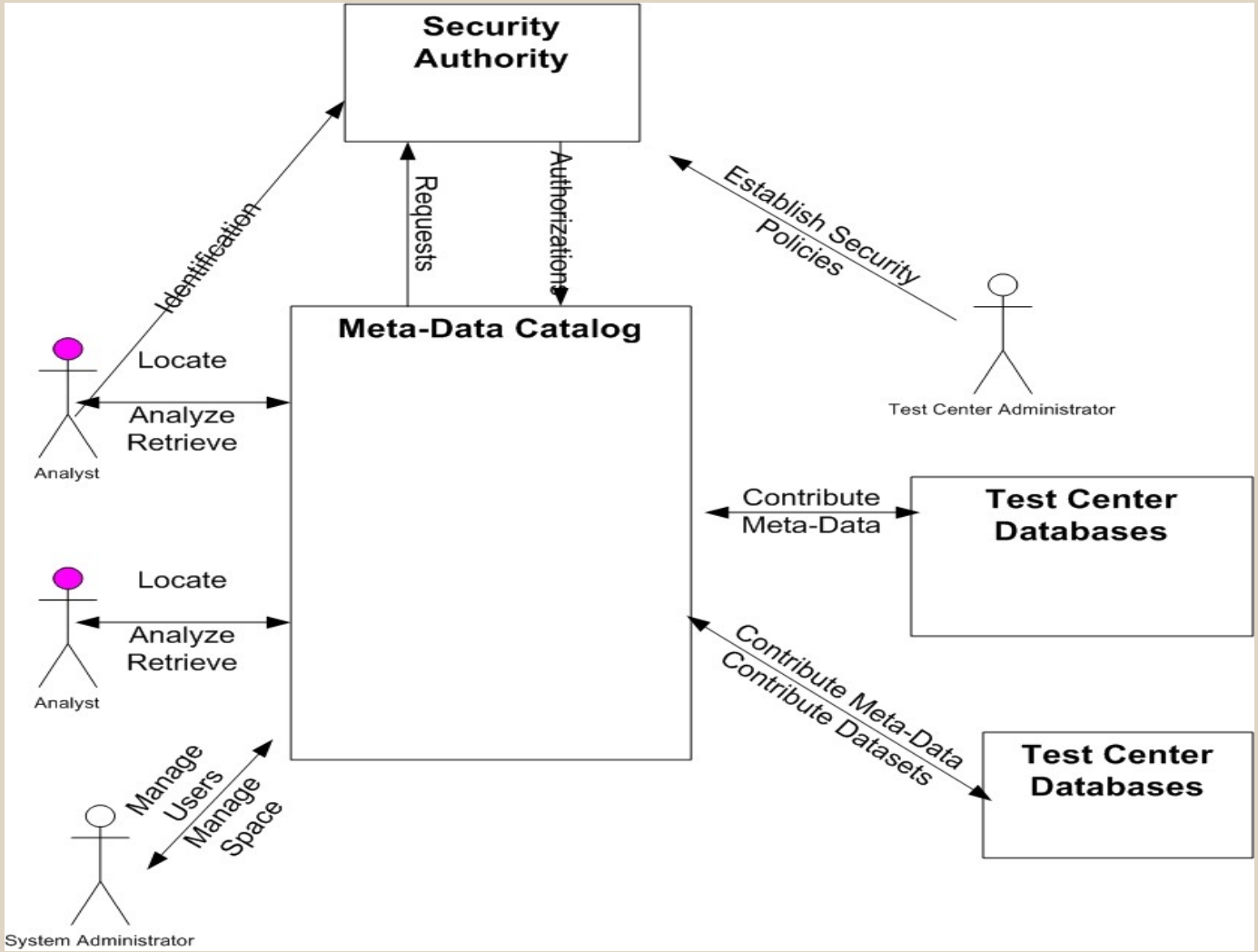
Context diagram



Activity Diagrams



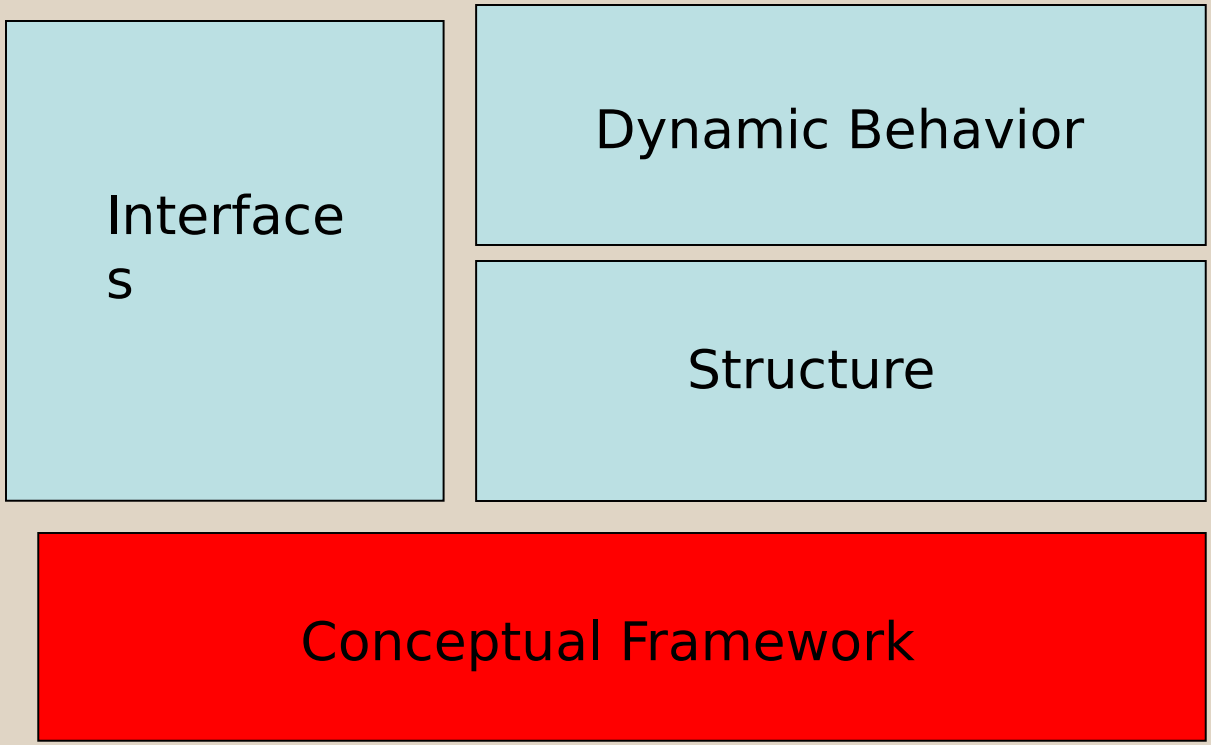
More Relevant Context Diagram



Use Cases

- Describes things the system does to provide to provide value to the Actors
- Usually text that focus on key success paths
  - Failures tackled as separate Use Cases
- Typical Components
  - Name
  - Assumptions
  - Pre-conditions
  - Dialog
  - Post – conditions
  - Exceptions
  - Future Enhancements
  - Issues

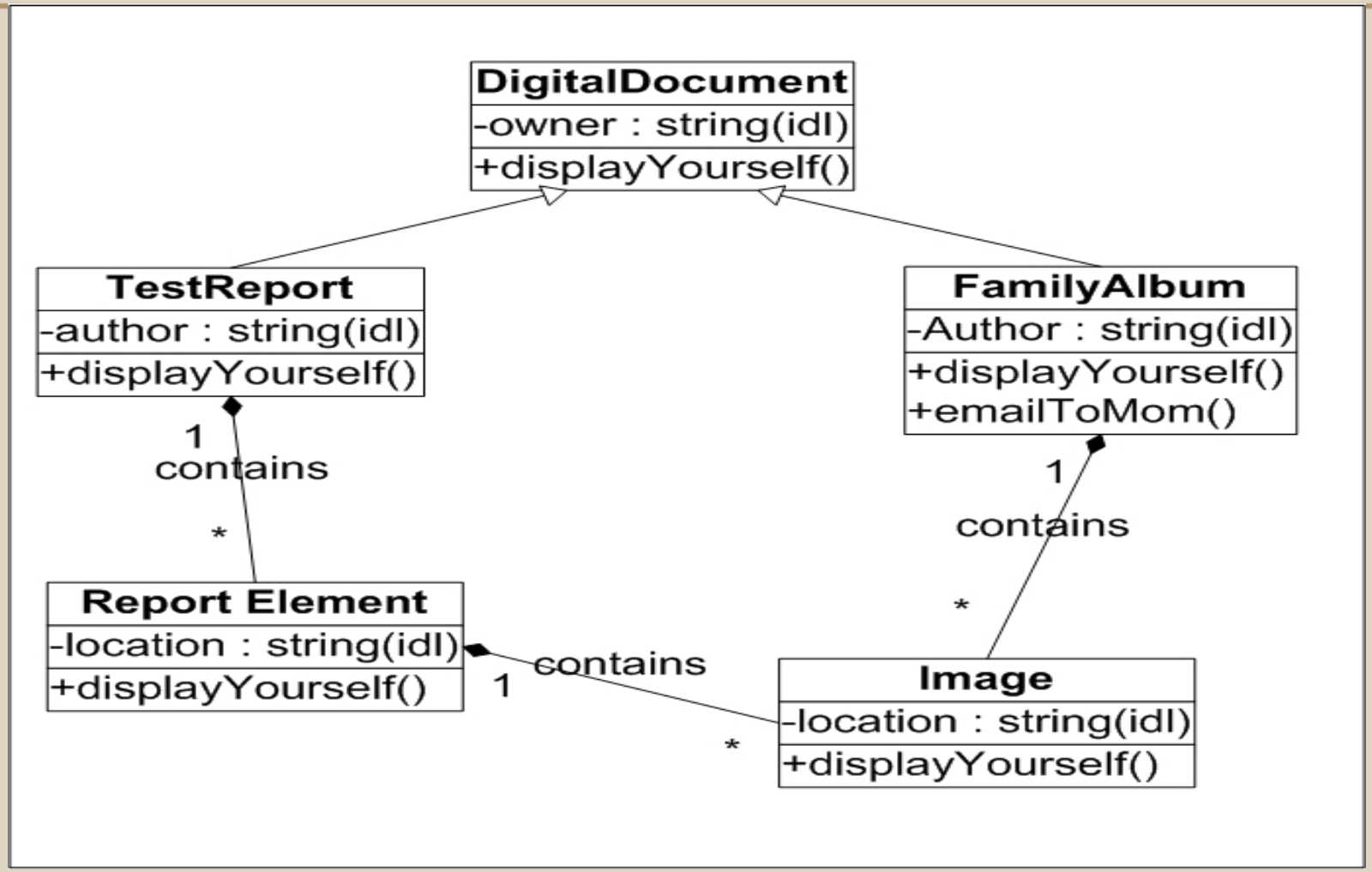
Using UML For Software Architecture Representations



Class Diagrams

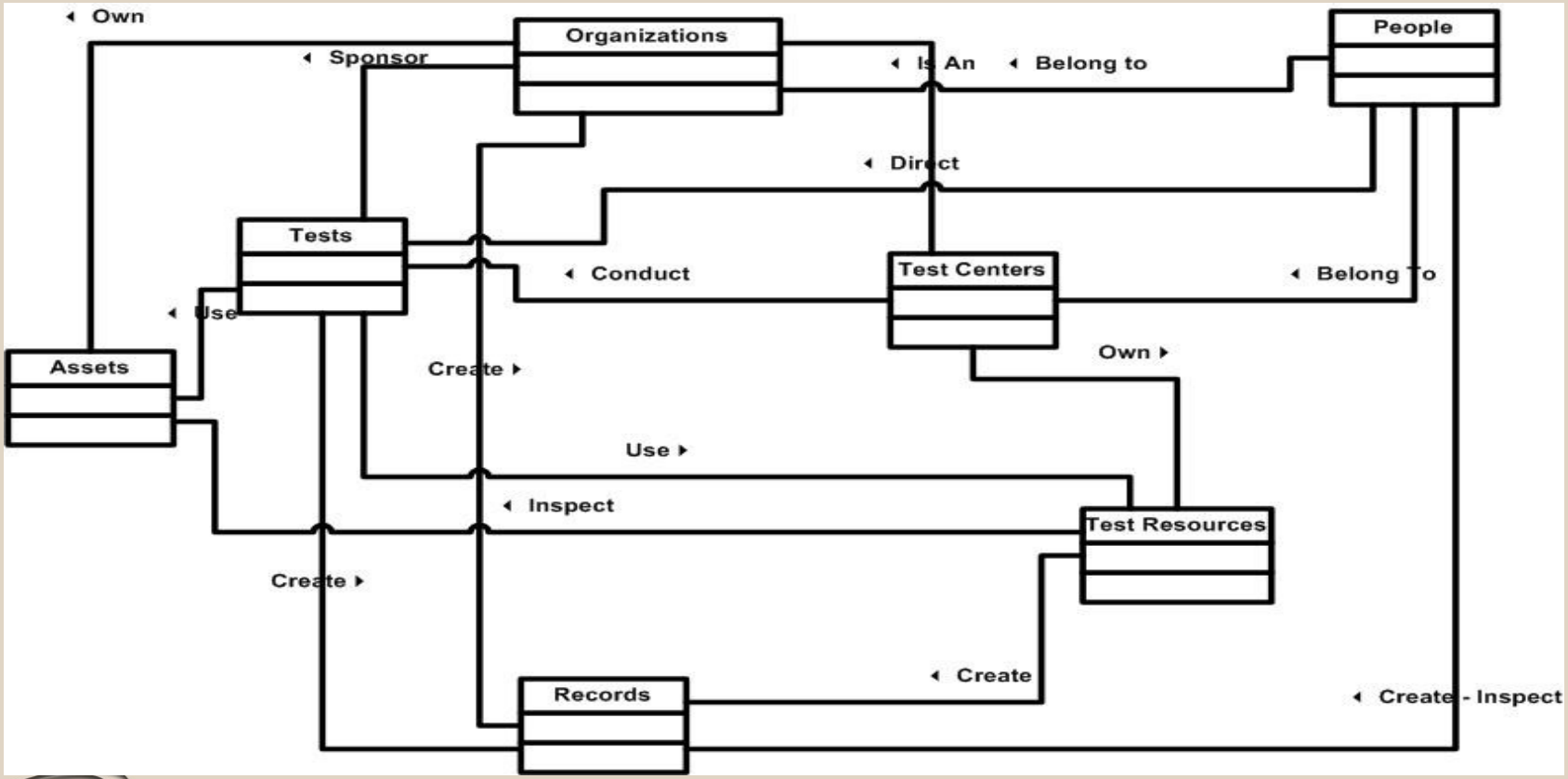
- application domain
- software design

Class Diagram

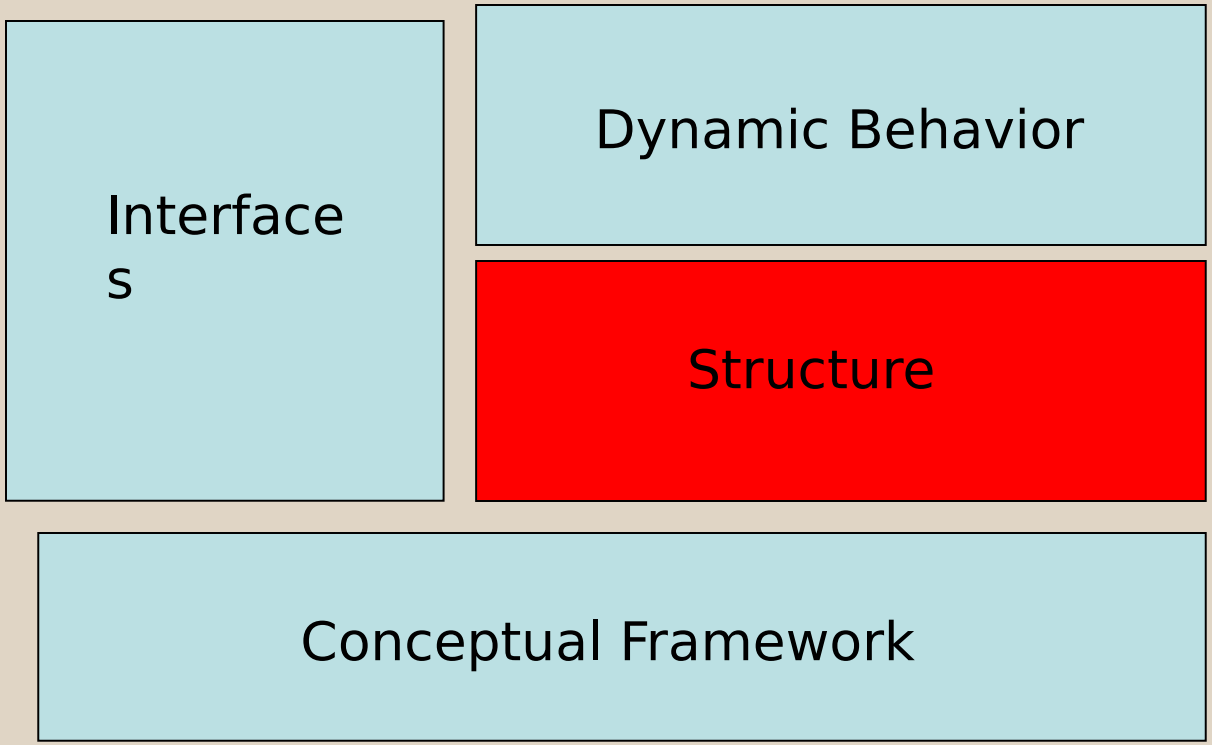


Class Diagram

Static Structure: things that exist and their relationships, some to become software objects, some not



Structure



Requirements Stage

-Context Diagrams

Development Stages

- Software components

- databases,

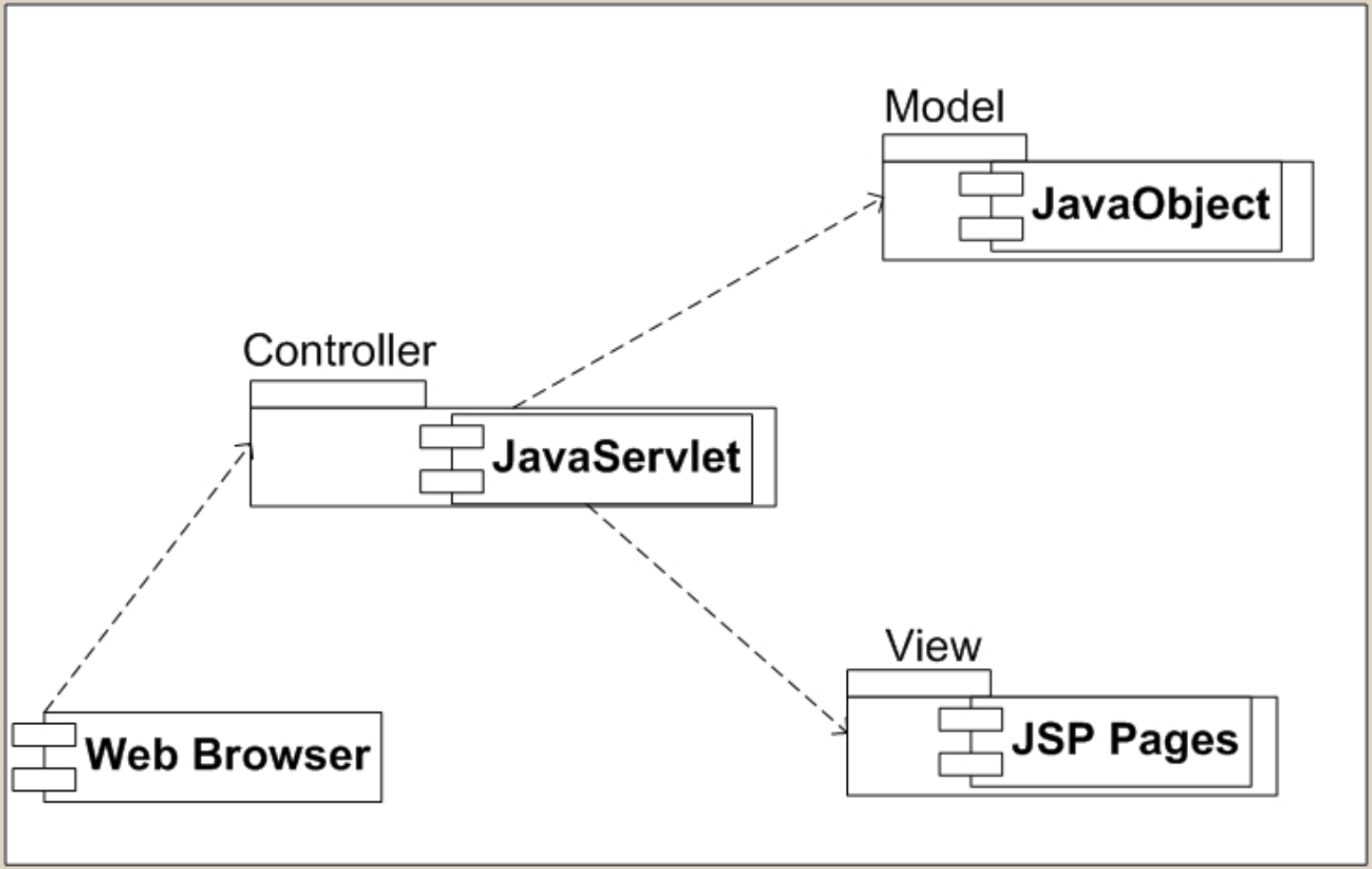
-software entities

CRC card level

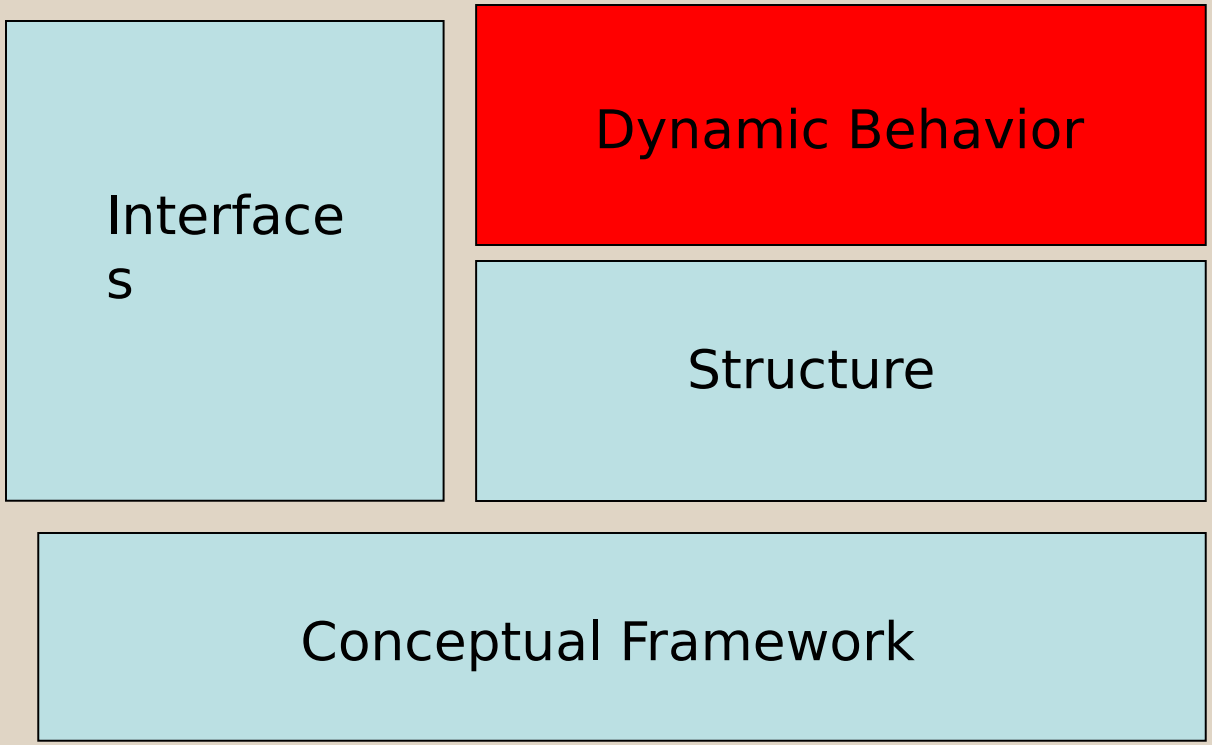
Component Specifications

Component	**A Unique Name**
Responsibilities	**Functions and Methods**
Collaborators	**Other Components that must be interfaced with**
Notes	**System constraints on the components, e.g., concurrency and persistence**
Issues	**List of issues remaining to be resolved**

Component structure example



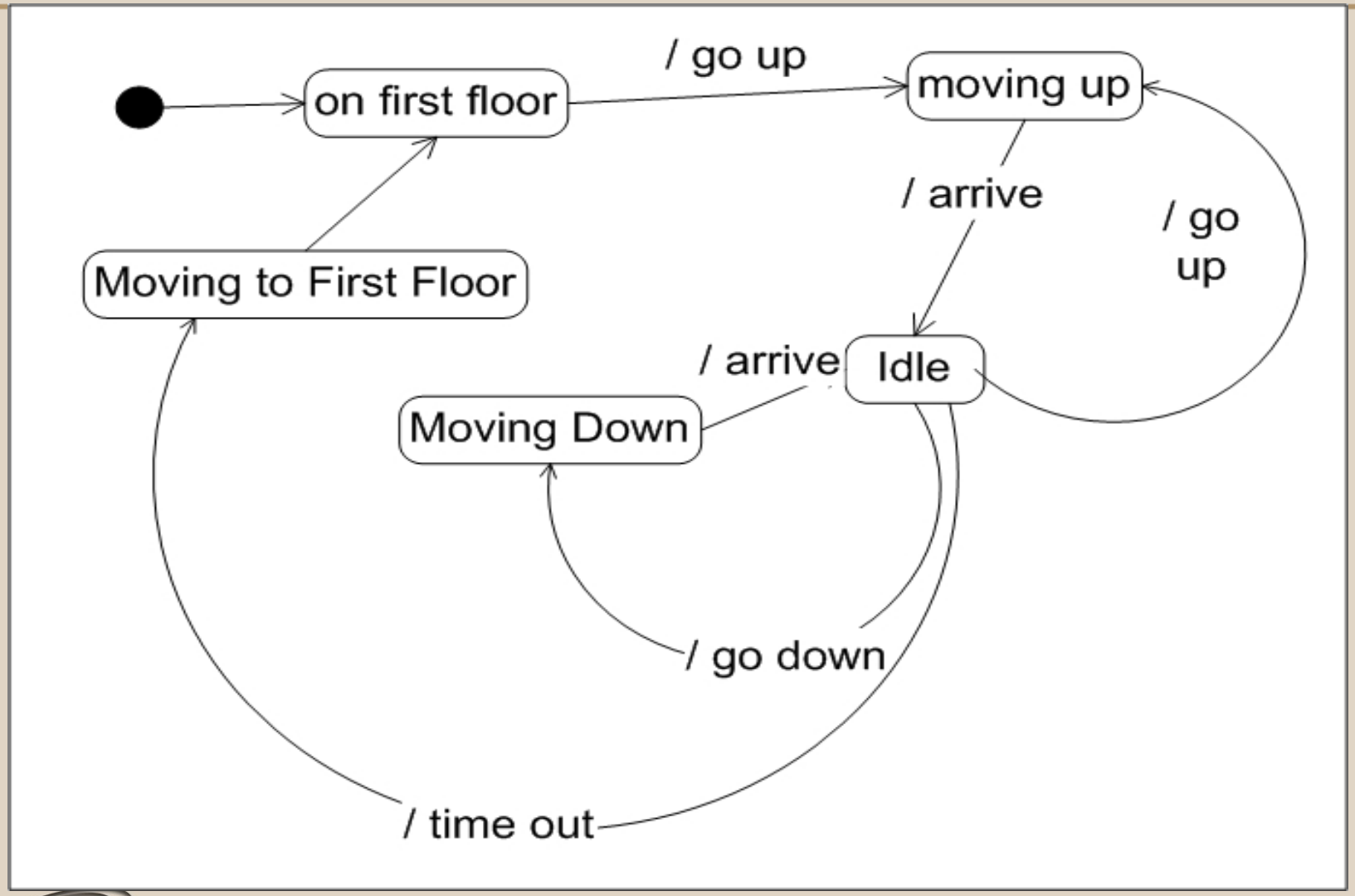
Dynamic Behavior



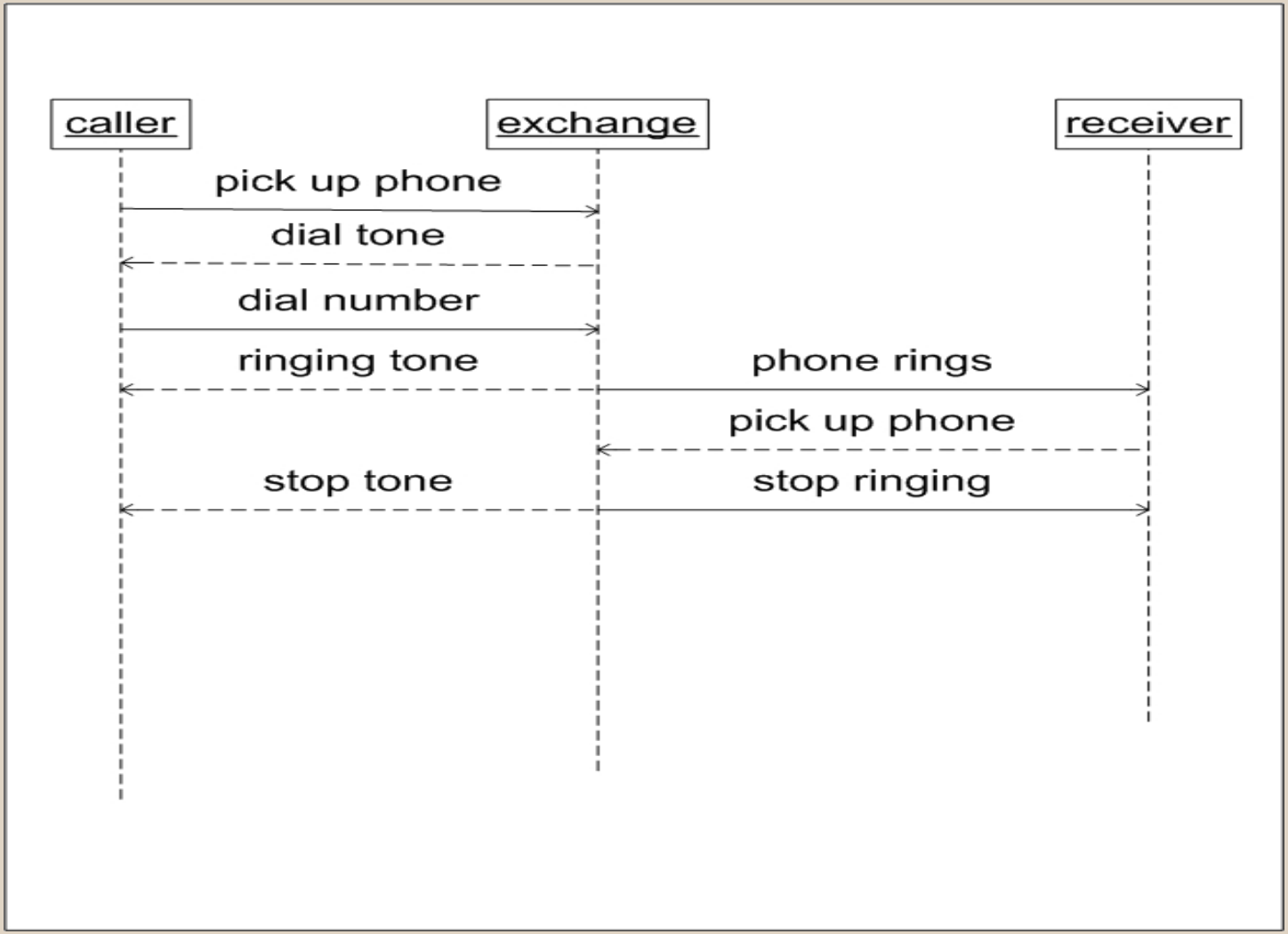
My personal opinion is that trying to document the flow of messages between objects is too hard.

I suggest one stick with activity diagrams at requirements and design stage and state charts as formality is needed

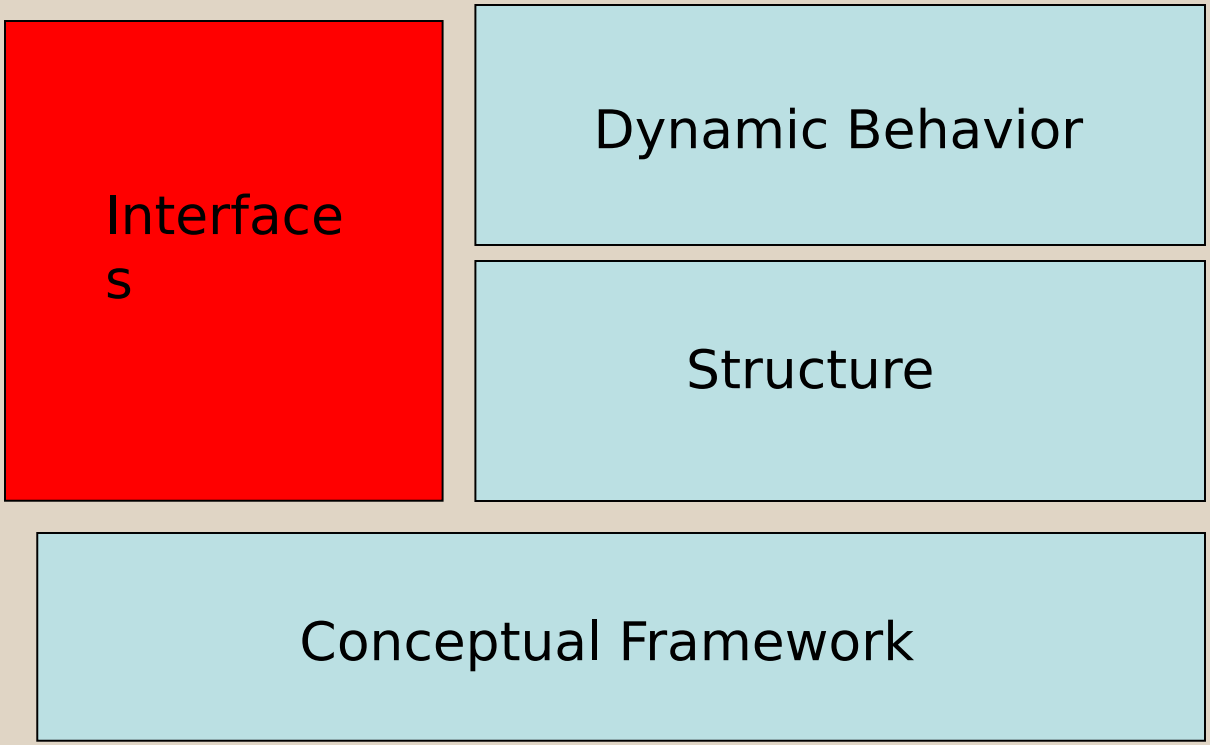
State Charts



Sequence Diagrams



Interfaces



Stick with an IDL description for the interfaces